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# EFFECTIVENESS OF HONEYCOMB PEDEGREE SELECTION IN INTRASPCIFIC COTTON CROSS.

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## ABSTRACT

The effectiveness of honeycomb pedigree selection (HPS) as compared to conventional pedigree selection (CPS) and mass selection (MS) were studied in one interaspecific cross between two promising hybrids Giza84 × ( Giza74 × Giza 68) and Giza 77 × Pima $S_6$ . Combined selection for yield and lint quality traits was applied for three cycles. Finally, the best $F_5$ lines derived by each method were tested in comparative experiments as randomized complete blocks design with three replications at Sakha Agric. Res. Station (2010). The analysis of variance indicated significant differences among of the selected lines for seed cotton yield and other traits except, for mean of boll weight. No significant differences were found between overall means of two groups CPS and HPS. In contrast, the mean of lines derived from third method MS . No significant differences however, were identified between the selected lines of the two methods ( HPS and CPS ) for lint quality traits. On the basis of mean seed cotton yield, boll weight, lint percent and fiber length as well as number of superior lines derived by each method. It was concluded that HPS was effective than CPS and MS in identifying lines with high yielding ability and a good lint quality. This superiority of HPS is attributed at least partially to its effectiveness in early segregating generation selection.

## INTRODUCTION

In conventional plant breeding programme, the opportunity for selection is limited not only by the parental genotypes and the size of population grown in early generation but , also by the ability of plants to express their genotype to distinguishable by plant breeder (Busbice and Wilisie 1970). The ineffectiveness of single plant selection for yield and yield components has been long recognized (Celami 1990 and Fasoula 1993) and has been attributed to low heritability resulting from inability of genotype to express it self sufficiently in the phenotype of one plant due to confounding effect of various macro and micro environmental factors (Kuott 1972). Fasoula, 1988, developed the honeycomb methodology of plant breeding and verified Shebeski,s envisioning(1967). The honeycomb methodology allows single plant selection for heritable high yield by facing the confounding effects on heritability of the following five factors, competition, stress condition, soil heterogeneity, genotype by environment interaction and heterosis in early generation. The confounding effects of the five factors are overcome:

1. Competition and stress condition due to density by growing plants in the absence of competition.
2. Soil heterogenty by honeycomb pedigree selection designs
3. G x E interaction multi environmental screening from the very beginning till and the end of the breeding programme.
4. Heterosis in early generation by taking measures that, increase the rate of gene fixation in the population being sampled.

Roupakias *et al.* (1997) pointed out that the honeycomb pedigree methods was effective in early generation selection of faba beans. Lungu *et al.* (1987) decided the same results for spring wheat. Gill *et al.* (1995) stated that the honeycomb selection method exhibited superiority over pedigree selection, single seed descent and bulk method for yield in mangbean. Also Batzios *et al.* (1997) reported that the honeycomb pedigree selection is more efficiency than pedigree selection for yield in cotton. The present study aim to evaluate an effectiveness of honeycomb pedigree selection (HPS) compared with both conventional pedigree selection (CPS) and mass selection (MS).

## MATERIALS AND METHODS

The fieldwork of this study was carried out at Sakha Agricultural Research Station (A.R.C) Egypt. Inbred lines of two promising hybrids Giza 84 × ( Giza 74 × Giza 68) and Giza 77 × Pima $S_6$ were crossed to produce the first filial generation ($F_1$). $F_1$,s seeds were divided into three groups to plant in three experiments for three selection methods; mass selection (MS), pedigree (CPS) and honeycomb (HPS) selection. The first group of mass selection in 2007, the seeds produced by 60 $F_2$ plants were bulked and grown in one plot consisting of 10 rows. The rows were 4 meter long and 70cm apart. Hills were spaced at 30 cm within row and seedling was thinned to single plant. A similar procedure was applied till the $F_5$ generation to produce the best selected three lines from this population.

The second group of selfed seeds from ($F_2$) was grown in one plot consisting 60 rows 7m long. Spacing was 0.7 m between rows and 70 cm between plants in the row. On the basis of seed cotton yield and lint quality, the best 35 $F_2$ plants were selected in 2007. The thirty-five $F_3$ plants were grown as individual families from the selfed seeds of $F_2$ selected (These individual families were planted as mentioned before). The natural seed of same selected plants were grown in one plot for every family consisting 3 rows 4.0 m long spacing between rows 0.70 m and between plants 0.30 m. These natural seed family were used to evaluate the seed cotton yield and fiber quality. On the basis of the best family, the best 21 plants were selected from $F_3$ generation in 2008. Similar procedure was applied for $F_4$ generation in 2009. The best 7 lines from 21 families of $F_4$ generation were selected and evaluated together with the ones selected by HPS and MS in 2010.

Third group of honeycomb selection in 2007, the selfed seeds were grown in honeycomb designs ensure objective selection among and within progenies by allocating progenies randomly across the selection site and by ranking them according to number of plants selected by of the moving circle. Each replicated design evaluated maximum number of progenies which is given in columns R1 and R2 of Table (1) the maximum number of entries is obtained by formulas R1= K2 where k assumes all integral values while, in designs of R2 type by the formula R2 = K2+k+1

In Table (1) Values in Colum k serve to calculate R1 and R2 to constrictive design in the following manure. The construction of the R-9 design in Fig (1) starts by 9 in the being of the first row and the first number of the second row is found by subtracting k-3 = 6. The first number of third outer row is found by substracting K+1. In general, the starting number of inner rows is obtained by substracting k from remainder and of outer row by substracting K+ 1.

**Table 1: Columns R1 and R2 give the maximum number of entries handled by the replicated honeycomb designs of type R1 = K2 and of type R2 = K2 + k +1. Values in column k serve to calculate R1 and R2 and to construct the design (Figures1 and 2)**

| $R_1$ | $R_2$ | $R_3$ |
|---|---|---|
| - | 3 | 1 |
| 4 | 7 | 2 |
| 9 | 13 | 3 |
| 16 | 21 | 4 |
| 25 | 31 | 5 |
| 36 | 43 | 6 |
| 49 | 57 | 7 |
| 64 | 73 | 8 |
| 81 | 91 | 9 |
| 100 | 111 | 10 |

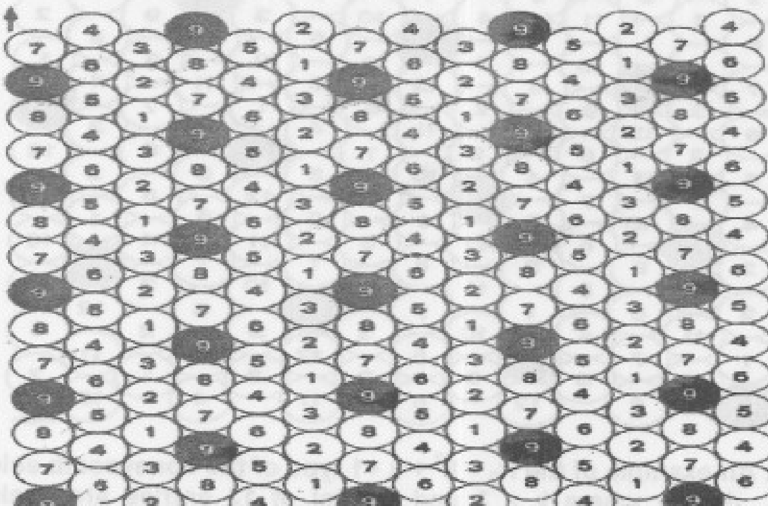

**Fig.1: An example of the R1 = k2 type of the honeycomb selection design where k = 3 and a total of 9 entries are evaluated. Entries are arranged across the experimental area a regular triangular pattern which ensures random allocation in respect to variations in environmental conditions and hence reliable evaluation. Each of the k first rows carries different set of k codes and the same code arrangement is repeated after 2k rows.**

When the remainder is smaller than the substrabend or zero we add R1 or R2 and continuous substrating after finding the starting number of all row which occur in zig-zag arrangement, the remanding position are filled up by using for first row the set of K larger number, for second row the set of the next K larger number and for third row, the smaller number of K. In design R2 type, all rows carry the same set of recurring number namely from 1 to R2. Thus, once starting numbers of row are found the remaining position is filled up by counting in ascending order up to R2 repeatedly. The $F_2$ plants were grown by designs R = K2 Fig (1) while the next generation were grown by designs R2 = K2 + K +1 Fig (2). The space between plants 100cm for all direction.

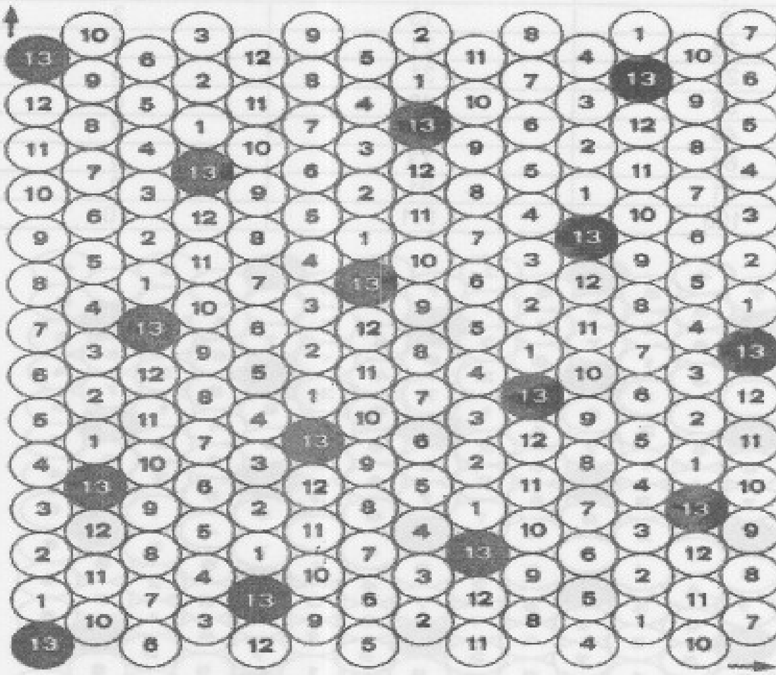

**Fig .2: An example of the $R_2 = k^2 + k + 1$ type of the honeycomb selection design where k = 3 and a total of 13 entries are evaluated. Entries are arranged across the experimental area a regular triangular pattern which ensures random allocation in respect to variations in environmental conditions and hence reliable evaluation. All rows carry the same set of $R_2$ codes which are repeated regularly starting with different code.**

Twenty $F_2$ plants (2007) were selected from designs R-9 which described before and the next season fifty five $F_3$ progeny (2008) from each of twenty plants were selected. Similar procedure was applied for fourth generation $F_4$. In the $F_3$ and $F_4$ generation, the selected plants were coming from higher yielding lines. In $F_5$ generation (2009) seven progeny from $F_4$ were selected. This lines together with ones selected by CPS and the three lines were selected by MS were evaluated in a randomized complete blocks design with three replications (2010). Each replicate consisted of 17 plots with five rows in each plot. The row was 4m long, 70 cm apart and 25 cm between hills. The hills were thinned to two plants. The following characters were considered:, seed cotton yield (grams),boll weight (grams),lint percent (L %), fiber fineness ( micronaire reading ) and Upper half mean in mm measured by HVI.

## RESULTS AND DISCUSSION

The means squares values were obtained from ordinary variance analysis (Table 2). It is clear that all lines differed significantly for all studied traits except, for boll weight also the results show that the lines derived by HPS differed significantly. Present findings were similar to the finding of Batzios *et al.* (1999). This results as ascertains that the fact of previous assumption for distinct the lines involved. This is in accordance with the statement that a selection scheme that allows parallel selection for general and specific adaptation from the first generation of the crop improvement program will increase efficiency (Fasoulas, 1993).

**Table (2): Mean square of studies traits for all selected lines.**

| Source of varition | d.f | Boll weight | Seed cotton yield | Lint% | Micronarie reading | Fiber Length |
|---|---|---|---|---|---|---|
| **Rep.** | 2 | 0.002 | 103452.8 | 0.11 | 0.071 | 1.264 |
| **Line (G)** | 16 | 0.083 | 1017735.1** | 1.97** | 0.072** | 1.926** |
| **Within HPS** | 6 | 0.058 | 563259.5 | 3.43** | 0.1038** | 2.037* |
| **Within CPS** | 6 | 0.032 | 202797.9 | 0.68 | 0.009 | 0.316 |
| **Within MS** | 2 | 0.010 | 652380.1 | 0.87 | 0.234** | 0.498 |
| **Error** | 32 | 0.044 | 252563.553 | 0.296 | 0.023 | 0.863 |

*,** significantly different at the 0.05 and 0.01 levels of probability, respectively

This is because 100 large number of $F_1$ seeds are enough to establish a replicated honeycomb field trial with large replicates per cross. In addition, the large number of seeds produced per plant enables evaluation and selection in the $F_2$ and following generations.

Selection of over mean of lines of the three methods of selection according to the results in Table 3, indicated that the differences between the two over means of two selection methods HPS and CPS were not significantly differ and these mean were higher than the mean of third selection methods, MS. These results indicated that there are an increasing effective of two selection methods to improvement cotton breeding programme.

The results in Table (3) indicated that CPS method was more efficiency in the selection of high fiber length lines than HPS method as the over means of selected lines

**Table (3): Mean seed cotton yield and lint quality characters of the groups of lines derived by three selection methods in population.**

| Selection methods | Boll weight(g) | Seed cotton yield(g) | Lint% | Micronarie reading | Fiber Length(mm) |
|---|---|---|---|---|---|
| HPS | 3.167 | 4553.57 | 35.09 | 3.36 | 34.82 |
| CPS | 3.248 | 4546.62 | 35.07 | 3.35 | 35.77 |
| MS | 2.9 | 3366.57 | 34.24 | 3.32 | 34.38 |

The results in Table (4) and Fig.3 showed that the mean traits of selected lines

With regard to seed cotton yield, results in Table 3, showed that the mean yield of HPS lines was similar to that of the CPS lines and significantly higher than mean yield of MS. Furthermore, five out seven HPS lines yielded higher than the best lines of MS. (Table 4), the yield of all CPS lines were higher than the best lines of MS.

Moreover, one HPS line out yielded the best other HPS and CPS lines. This result indicates that HPS for yield was more effective in selecting good plants in $F_2$ and subsequent segregating generation than CPS. These results due to HPS selected little number of plants in $F_2$ than those of CPS selected lines. The effective of HPS may be due to the plants in HPS were planted in an equilateral triangular pattern while, in CPS methods were planted in rows, (Fasoula and Fasoula 1997b).

**Table (4): Means of seed cotton yield and lint quality characters of lines derived by three selection methods in population.**

| Selected line | Methods | Boll weight (g) | Seed cotton yield(g) | Lint% | Micronarie reading | fiber length |
|---|---|---|---|---|---|---|
| 1 | HPS | 3.43 a | 4980.0 ab | 35.62 b | 3.33 efg | 34.53 hi |
| 2 | HPS | 3.16 cdef | 5247.0 a | 37.09 a | 3.53 ab | 34.90 fgh |
| 3 | HPS | 3.16 cdef | 4043.0 gh | 34.21 ghi | 3.23 g | 34.57 hi |
| 4 | HPS | 3.23 bcd | 4442.0 def | 34.37 fg | 3.30 fg | 36.33 a |
| 5 | HPS | 3.10 def | 4652.0 bcd | 34.31 fgh | 3.60 a | 35.27 efg |
| 6 | HPS | 3.03 fg | 4208.0 fgh | 34.42 efg | 3.06 h | 33.67 j |
| 7 | HPS | 3.03 fg | 4303.0 defg | 35.59 b | 3.47 bcd | 34.50 hi |
| 8 | CPS | 3.36 ab | 4449.0 def | 34.68 def | 3.30 fg | 36.03 abc |
| 9 | CPS | 3.20 cde | 4295.0 efg | 34.79 de | 3.40 cdef | 35.93 abcd |
| 10 | CPS | 3.26 bc | 4273.0 efg | 34.48 efg | 3.33 efg | 35.30 defg |
| 11 | CPS | 3.23 bcd | 4439.0 def | 34.96 cd | 3.37 def | 35.47cdef |
| 12 | CPS | 3.06 efg | 4589.0 cde | 35.20 c | 3.43 bcde | 35.60 bcde |
| 13 | CPS | 3.36 ab | 4832.0 bc | 35.70 b | 3.30 fg | 35.87 abcde |
| 14 | CPS | 3.23 bcd | 4950.0 ab | 35.66 b | 3.30 fg | 36.20 ab |
| 15 | MS | 2.83 h | 3020.0 i | 33.96 hi | 3.50 abc | 34.47 hi |
| 16 | MS | 2.93 gh | 3183.0 i | 33.91 i | 3.46 bcd | 33.93 ij |
| 17 | MS | 2.93 gh | 3897.0 h | 34.87 cd | 3.47 bcd | 34.73 gh |

Also, the selection pressure from $F_2$ and respective generation by HPS was higher than applied by CPS. Effective HPS in early generation has been reported by other workers (Lungu *et al.* , 1987; Roupakias *et al.* , 1997).

With regard to boll weight, the results in Figure 3 and Table 4 showed that only one HPS's line selected followed by two CPS lines were higher boll weight than the other lines of HPS and CPS. Moreover, the most selected lines by (HPS and CPS) methods exhibited higher boll weight than that of the best lines of MS. The results in table (4) gave the same trend for seed cotton yield due to the boll weight consider as one of yield components.

For the lint percentage, the results in Table 4 and Fig 3 showed that only one line selected by HPS was significantly higher than that of the lines selected by CPS and MS methods . The high lint percent line was followed by two HPS lines and two CPS lines.

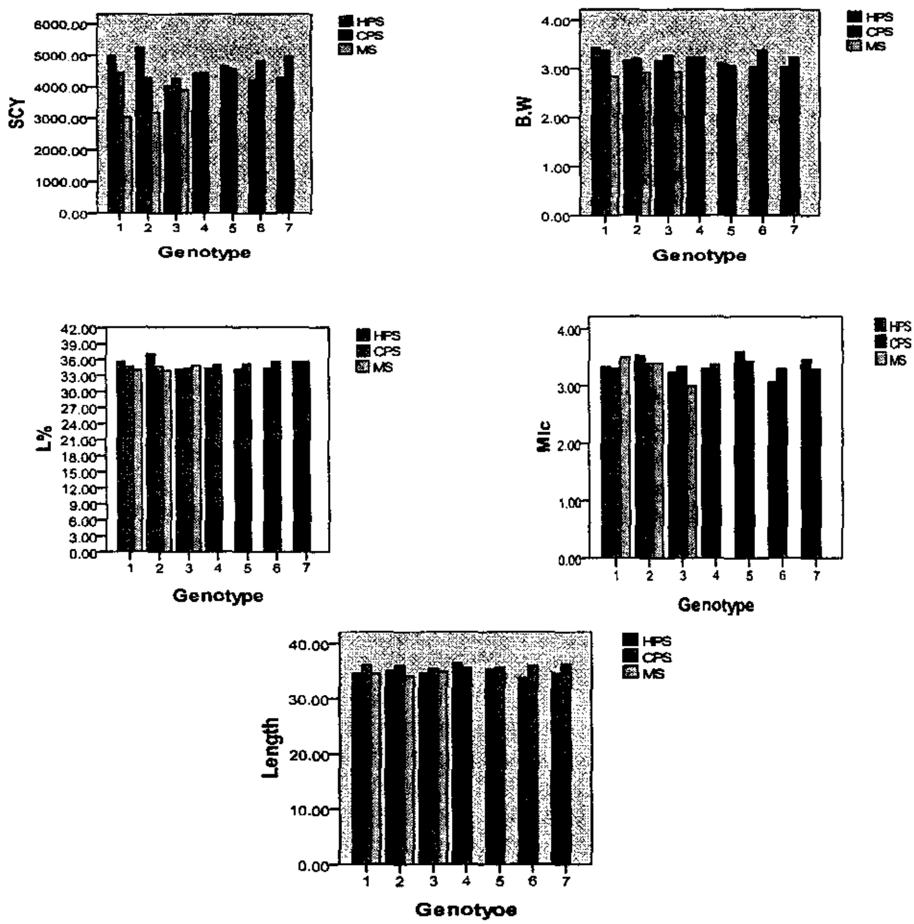


**Fig. 3: Mean performance of the line selected by HPS, CPS and MS for five traits.**

For fiber quality traits, the combined selection for yield and fiber quality applied in all generations resulted in an identification of lines with good fiber traits by both pedigree methods (HPS and CPS). Over lines, however, CPS lines were ranked first and significantly longer fibers than HPS lines (Table 3). In addition, HPS lines were ranked second and significantly longer than the length of MS lines.

According to fiber fineness (micronaire reading), one of HPS lines was finer than the other selected lines (included HPS, CPS and MS). Considering the relative fixed gene in higher number in $F_2$ generation, (Batzios *et al.* 2001)

It may be concluded that the superiority of one line of HPS is due to the absence of competition and possibility offered by honeycomb design to select simultaneously among and within lines, Lunga *et al.* (1987) reported that HPS for yield was effective in early generation of spring wheat.

It is concluded; therefore, the superiority of HPS in selecting lines with higher yielding over CPS is due to at least partially to effectiveness of HPS in early generations. The effectiveness of HPS in isolating line with higher yielding due to estimates of individual and progeny phenotypic values (breeding value) based principally on yield measurements that affected by competition and soil heterogeneity , so both of watch may limit the expression and confound differentiation of yield potential in other methods.

## REFERENCES

Busbice T.H. C.P. Wilsie, 1970. Inbreeding depression, heterosis in autotetraploid with applied to Medicago sativa L. Euphytica 15:62-67.

Batzios, D.P. & D.G. Roupakias, 1997. HONEY: A microcomputer program for honeycomb design analysis. Crop Sci 37: 744–747.

Celami A.N. 1990. I maziki kipseloti epilogji atin veltiosi stin midhisi (Medicago sativa L and Dissertation.Athens.1990 (Greek).

Fasoulas, A.C., 1988. The Honeycomb Methodology of Plant Breeding. Dept. of Genetics and Plant Breeding, Arist. Univ. of Thessaloniki, Greece. pp. 42–49.

Fasoulas, A.C., 1993. Principles of Crop Breeding. Thessaloniki. Greece.

Fasoula, D.A. & V.A. Fasoula, 1997b. Gene action and plant breeding. Plant Breed Rev 15: 315–374.

Gill, J.S., M.M. Verma, R.K. Gumber & J.S. Brar, 1995. Comparative efficiency of four selection methods for deriving high yielding lines in mung bean (Vigna radiata L. Wilczek). Theor Appl Genet 90: 554–560.

Knott, D.R., 1972. Effects of selection for F2 plant yield on subsequent generations in wheat. Can J Plant Sci 52: 721–726.

Lungu, D.M., P.J. Kaltsikes & E.N. Larter, 1987. Honeycomb selection for yield in early generations of spring wheat. Euphytica 36: 831–839.

Roupakias, D., A. Zesopoulou, S. Kazolea, G. Dalkalitses, A. Mavromatis & T. Lazaridou, 1997. Effectiveness of early generation selection under two plant densities in faba bean (*Vicia faba* L.). Euphytica 93: 63–70.

Shebeski, L.H., 1967. Wheat Breeding. In: K.F. Nielsen (Ed.), pp. 249–272, Proc Can Centennial Wheat Symp Saskatoon, Saskatchewan.

# كفاءة الإنتخاب بطريقه قرص العسل فى هجين صنفى للقطن

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إجريت ثلاثة طرق انتخاب وهى الانتخاب المنسب بطريقة القرص العسلى والانتخاب الفردى المنسب والانتخاب الاجمالى على الهجين جـ٨٤ × (جـ٧٤ × جـ ٦٨) × ( جـ ٧٧ × بيما س٦ ). تم تقسيم بذرة الجيل الاول الى ثلاثة مجموعات لزراعة الجيل الثانى (٢٠٠٧ ) المجموعة الاولى زرعت بطريقة القرص العسلى مع انتخاب مركز الشكل السداسى والمجموعة الثانية زرعت بطريقة الانتخاب المنسب للنباتات الفردية والمجموعة الثالثة تم زراعتها بطريقة الإنتخاب الاجمالى.

-أجريت ثلاث دورات انتخاب (٢٠٠٧ - ٢٠٠٩) تم على اثرها انتخاب سبعة سلالات بطريقة الأنتخاب بقرص العسل (HPS) و سبعة سلالات بطريقة الأنتخاب الفردى (CPS) وثلاثة سلالات بطريقة الأنتخاب الأجمالى (MS). تم تقييم كل السلالات المنتخبة وعددها (١٧ سلالة) فى تجربة قطاعات كاملة عشوائية( ٢٠١٠) وتم تقدير الصفات الآتية:

١- محصول القطن الزهر/جم
٢- وزن اللوزة/جم
٣- تصافى الحليج
٤- النعومة (قراءة الميكرونير)
٥- طول التيلة

**وتم تحليل التباين واختبار LSD مع ترتيب السلالات وكانت أهم النتائج:**

- وجود اختلافات معنوية بين جميع السلالات بالنسبة لجميع الصفات المدروسة ما عدا صفة متوسط وزن اللوزة على اساس المتوسط العام للسلالات المنتخبة بطريقتى النسب ( القرص العسلى والفردى).
- لا توجد اختلافات معنوية بين المتوسطين HPS , CPS ( المتوسط العام ) بينما توجد اختلافات معنوية بينهما عن متوسط السلالات المنتخبة إجماليا MS .
- وعلى متوسط كل سلالة منتخبة كانت السلالات المنتخبة بطريقة القرص العسلى اعلى قيمة مما يدل على ان الانتخاب بطريقة الفرص العسلى اكثر تاثيرا من الطريقتين الأخريين فى الأجيال المبكره.

**قام بتحكيم البحث**

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